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ABSTRACT

A 1984-85 study of Palau elementary students, who were pretested, instructed with a textbook and additional practice booklets, and posttested, revealed gains for every skill at every grade level. A 1986-87 study, using a series of 26 booklets representing a fairly complete math curriculum, showed that students using the experimental booklets gained more during the year than students using regular textbooks. A longitudinal study conducted between 1985 and 1992 showed decreasing scores over the period. Overall competence in mathematics at the sixth through eighth grade level was most highly correlated to recall of division facts. Students scored higher on the computational component than on the application component of the test. Evaluation of 1993 data indicated that girls in grades 2 to 8 outperformed boys on each of the subskills. Scores on the Stanford Achievement Test administered to some students in grades 4, 6, 8, 10, and 12 showed that girls outperformed boys at each grade level except 12. This performance is attributed to the fact that girls in Palau must go home and remain there after school while boys are free to roam about; hence, girls are more likely to do their school work. As boys get closer to graduation, they begin to take their studies more seriously and improve their performance. The outcomes of the studies strongly suggest that social factors are just as, or more important than genetic factors with regard to math performance. Sixteen data tables are attached. (JDD)

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Who is Better in Math, Boys or Girls?

A Report from the Palau Math Project

A Presentation by

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Introduction

KING: Hafa Adai! Thank you for coming to our presentation today. My name is Irv King; I am an Associate Professor of Education at the University of Hawaii. Assisting me today are two high school mathematics teachers from Palau High School, Martina Basilius and Raynold Mechol. For the past ten years I have been assisting the Ministry of Education in Palau in evaluating the mathematics achievement of students in three of its elementary schools. During this decade the project has examined many different aspects of student achievement, and we will share some of them with you today. One of our more interesting findings is that Palauan girls outperform Palauan boys in mathematics at all grade levels until their senior year in high school. We will get to this later in our presentation. But first, since some of you in the audience may not be familiar with the Republic of Palau, we would like to give you a brief sketch of the Republic and explain the educational evolution which is taking place there. These are interesting and dynamic times for Palau, as you shall see. Throughout this presentation Martina, Raynold and I will take turns in providing you with information. We will begin with some background information on Palau.

MARTINA: Palau is an island nation of 15,000 people located in the Pacific Ocean south of Guam, east of the Philippine Islands, and north of New Guinea. We have a videotape which shows some scenes of Palau to give you an idea of what it is like. It is a home video shot by Dr. King while he was in Palau this last May, so while it is not of professional quality, it will give you a good glimpse of Palau and the schools involved in our study.

[The tape includes aerial shots of the beautiful Rock Island of Palau, underwater shots of the beautiful fish and corals about the islands, scenes about the town of Koror, and scenes of students at each of the three elementary schools involved in the study.]

RAYNOLD: The people of Palau have been in the islands for many centuries, having come from southeast Asia. The western world became aware of these islands when they were discovered by the Spanish explorer Villalobos in 1543, and since then the islands have been under a succession of foreign rulers. Germany purchased the islands from Spain in 1899 following the Spain's defeat in the Spanish-American War. During World War I, in 1914, Japan seized the islands from Germany without resistance, and the Versailles Peace Conference of 1920 gave legal authority over the islands to the Emperor of Japan. In 1944, the United States gained control of the islands in one of the bloodiest battles of World War II, and in 1947 the United Nations created the Trust Territory of the Pacific Islands which placed Palau and the other regions of Micronesia under the administrative control of the United States. And so, for the past 100 years the islands of Palau have been subjected to a succession of foreign rulers who claimed rights to the islands by reason of conquest.

KING: After three decades of the trusteeship, the United States offered each member of the Trust Territory the option of negotiating new political alliances with the United States. The Northern Mariana Islands acted swiftly and became a commonwealth of the United States in 1976; Chuuk (formerly called Truk), Kosrae, Pohnpei (formerly called Ponape), and Yap joined together to form the Federated States of Micronesia and negotiated their independence in 1986; and in the same year the Marshall Islands signed a similar agreement. The Federated States of Micronesia and the Marshall Islands have entered into a compact of "free association" with the United States whereby each region assumes responsibility for their own internal affairs and the United States retains responsibility for the military defense of the regions.

MARTINA: While the peoples of the other districts were voting in favor of new political alliances with the United States, the people of Palau voted against ratification of a treaty in seven consecutive plebiscites. A major obstacle to ratification was the

insistence of the United States to have nuclear weapons in Palauan waters. Since the Palauan constitution specifically bans nuclear weapons, and since the constitution requires a 75% vote to change any clause in the constitution, ratification of a treaty required a 75% vote of the people. This past year the 75% vote requirement was changed to a simple majority. An election was held approving a compact with the United States, and in October of this year Palau will become an independent nation with complete control of its internal affairs.

Public Schools in Palau

RAYNOLD: Spanish and German missionaries were the first teachers in Palau, and their instruction consisted primarily of catechism classes taught for the children of the socially elite. Formal public education began during the Japanese administration and consisted of three years of elementary schooling and a supplementary two year program for the more able students. Qualified teachers from Japan ran the schools, and the curriculum consisted of a wide variety of subjects, including Ethics, Japanese Language, Arithmetic, Natural Science, Physical Exercise, and Agriculture.

KING: Under the American rule school buildings were built in all fourteen villages - there were only four schools in Japanese times - and an elementary school education became available to all children in Palau for the first time. English supplanted Japanese as the official language of the school, and the major focus of the curriculum was academic in nature and closely resembled the curricula found in American schools. Because there were no certified teachers available to teach in these new American-style schools, respected Palauan elders who had attended Japanese schools were recruited as the first teachers.

MARTINA: The initial strategy for training teachers was to send prospective teachers from throughout Micronesia to the Marianas Area Teacher Training School located in Guam. However, by 1952 the teacher training function of the school was terminated and

each district became responsible for training its own teachers. Teachers were placed on 12-month contracts which required them to teach school for nine-months and attend college courses offered in Palau by American universities during the summer months. This summer program became the teacher training model for Palau.

RAYNOLD: This teacher training strategy was followed for nearly three decades, and in spite of the good intentions, very few of the teachers were able to obtain a quality higher education. By 1980 only 20 percent of about 250 teachers had four-year college degrees, and these teachers had to go overseas to obtain their degrees. Palau was not unique in this regard, for the other territorial possessions of the United States were facing similar challenges, and in 1978 the United States government responded to this common need for qualified teachers by establishing the Territorial Teacher Training Assistance Program (TTTAP). The purpose of TTTAP was to provide funds for training teachers in the territorial possessions of the United States, including American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, the Marshall Islands, Palau, and the Virgin Islands.

KING: By 1987 Palau was the only remaining member of the Trust Territory, and the huge bureaucracy which once managed the Trust Territory had been largely dismantled. This reduction in manpower gave the Ministry of Education in Palau an opportunity to administer its own programs for the first time. The ineffectiveness of previous teacher training programs convinced the Ministry that new approaches were needed.

MARTINA: An American university with experience in international education agreed to open a temporary campus in Palau with the goal of developing a two- or three-year academic program in which teachers could earn a Bachelor of Arts degree with a Diversified Major. The program was designed by Palauans to meet their unique needs. When the program ended in 1990 after ten quarters of study, eighty-nine of the 157 teachers enrolled in the program had earned their degrees. Thus, in a single graduation

ceremony the number of teachers with college degrees increased from 22 percent to 61 percent.

RAYNOLD: During this time of political uncertainty, the Ministry of Education also wanted to monitor the academic achievement of its students, and in 1984 it began a study to improve the mathematics achievement of students at an elementary school in Koror. Since then a number of studies have examined the math achievement of students in Palau. In today's session we would like to describe these studies and share some of the more interesting results with you.

The 1984-1985 Study

KING: In 1982 I was asked by the Mathematics Specialis, Basilio Deltang, if I would work with him towards improving the math achievement of students in Palau. Although funds were very limited, it was expected that Palau would negotiate a political agreement with the United States in the very near future, and when this occurred, it was hoped that funds would become available for a major curriculum effort in Palau. With this in mind, I developed a Mathematics Scope and Sequence Chart for the schools of Palau and presented it to the Ministry of Education. Some topics were moved to later grades and other topics were eliminated from the curriculum altogether (such as set theory). I then wrote a computer program which would generate arithmetic problems to precise specifications. The idea was to present computational skills one step at a time. For example, a 2-digit by 2-digit multiplication problem with no carrying in the multiplication and no carrying in the addition preceded a 2-digit by 2-digit multiplication problem with carrying in the multiplication and no carrying in the addition, and this preceded a 2-digit by 2-digit multiplication problem with carrying in both multiplication and addition. I then put these problems, which increased with difficulty in a clear and logical sequence, into four booklets to test with the students at a large elementary school in Koror, the district capital. One booklet on addition, one on subtraction, one on

multiplication, and one on division. Since there is no kindergarten in Palau, and since first graders speak English with limited proficiency, a decision was made to test the addition booklets with second graders, the subtraction booklets with third graders, the multiplication booklets with fourth graders, and the division booklets with the fifth graders. The students were pretested in September of 1984, the teachers used the booklets to supplement the regular textbook to provide students with additional practice, and then the students were posttested in May of 1985. The tests consisted of computational skills as shown in Table 1. Students were given one minute to complete 30 facts (such as 3 + 6) and two minutes to complete six computation problems (such as 378 + 275).

[Insert Table 1 here]

A number of different things can be seen from the results. First, notice that there were gains for every skill at every grade level. For example, at the second grade, students scored 23 percent on addition facts on the pretest, 76 percent on the posttest. The pretest-to-posttest gain was 53 percent. The largest gain was for addition problems at the second grade with a 60 percent increase, the smallest was for subtraction facts at the third grade with only a nine percent increase. It can also be seen from the fifth grade that students are stronger on addition (98%), then subtraction (77%), then multiplication (54%), and they are weaker division (36%). This is as expected. Also note that the scores increase as the students get older. For addition problems, the second graders score 79%, the third graders score 82%, the fourth graders 93%, and the fifth graders 98%. This is also as expected.

The 1986-1987 Experimental Study

RAYNOLD: Nothing was done the following year, but in 1986-1987 another attempt was made to improve math achievement in the same school. This time a series of 26 booklets was developed, one for each letter of the alphabet, . These booklets contained

more than just computational skills and represented a fairly complete curriculum. In the previous study, it was not known if the supplementary booklets had been beneficial because there was no control group with which to compare the outcomes. Therefore, a decision was made to conduct a Pretest-Posttest Control Group Design Study. One class at each grade level (second grade through sixth grade) served as the Experimental Group and used the series of 26 booklets instead of their regular math books, and the other classes served as the Control Group and used the regular school textbook. The students at a second school also were tested and were a part of the Control Group. The two groups were pretested in September 1986 and posttested in May 1987.

[Insert Table 2 here]

KING: The results are shown in Table 2. At each grade level, the students using the experimental booklets gained more during the year than the students in the control classes using the regular textbooks. The largest gain was at the sixth grade.

The Longitudinal Study

MARTINA: The people of Palau had failed to ratify a treaty with the United States in several more plebescites, and Palau remained in a political limbo. Therefore, although the results of the experiment were quite positive, funds were not available to continue the project, and nothing was done for the next two years. Then, in 1990, a decision was made to test the students again to see how they compared to the student scores in 1985 and 1987. This was the start of what became a longitudinal study. The testing has been repeated each year since then.

KING: Table 3 shows an average score for each grade level for the years 1985, 1987, 1990, 1991, 1992, and 1993. This average was arrived at by dividing the number of problems worked correctly by the total number of problems on the test. As can be seen, scores declined in School A since 1985. Between 1985 and 1992, the second grade scores decreased by 20%, the third grade by 4%, the fourth grade by 11%, and the fifth

grade by 8%. However, it should be noted that the scores in 1985 and 1987 reflected the use of booklets designed to improve basic arithmetic skills, and this might account for the higher scores in those years. Allowing for the possibility that the use of the experimental drill and practice booklets had a positive influence on the scores, the size of the decline in achievement does not appear to be large.

[Insert Table 3 here]

Achievement scores at School B have improved slightly from 1987 to 1992. This is important because during the past two years the school has become a year-round school in which students attend 45 days and are off for 15 days. This pattern of attendance has not harmed the mathematics achievement of its students.

The 1993 Results in More Detail

RAYNOLD: We looked at other data in addition to the longitudinal data. The total test score is the average of all of the items on a test. It gives a measure of the individual student's competence in mathematics. We wanted to know which of the various skills were most related to mathematics achievement, so we calculated the correlation between the various subskills and the total test score for sixth graders.

[Insert Table 4 here]

KING: As seen here, recall of the division facts is the skill most highly correlated to overall competence in mathematics at the sixth grade level. That is to say, if you score high on division facts, you tend to score high on the total test. This also means that a knowledge of the division facts is the single best indicator of mathematics competence as measured on this test. The ability to compute with fractions has the lowest correlation with overall test score.

7th and 8th Graders Added to the Study in 1993

MARTINA: In 1993 a third school was added to the study, and we included the 7th and 8th grade for the first time. Instead of merely measuring the ability to solve word

problems and the compuational skills with whole numbers, decimals, and fractions, a more comprehensive test was designed to measure a fuller spectrum of math concepts and skills taught at the 7th and 8th grades.

[Insert Table 5 here]

KING: As before, the test was not a multiple choice test. Students were required to work the problems on the test paper. We prefer this type of test because it eliminates guessing. This overhead of table 5 shows the type and number of math concepts and skills tested and the time allotted for each type of problem. For example, students were allowed five minutes to complete 35 addition problems, two minutes to complete 6 percent problems, and so on. While this is not a complete list of skills found in textbooks, we think this is a good representation of the more important skills and concepts taught at these grade levels.

RAYNOLD: The results of the testing for grades 7 and 8 in 1993 are given in Table 6 and Table 7. We have included these tables to show how the test can be used to identify areas of strength and areas of weakness. And although we have not focused on it, they also show the relative strengths of the three schools on each skill.

KING: Table 6 shows the results for the seventh graders in 1993, Table 7 the eighth graders. A number of interesting facts can be obtained from Table 6. For example, all three schools score well on addition - 95%, 97% and 91%. But they all three did very poorly on percent problems - 4%, 5% and 3%. This information can be useful to teachers. The total percent for each school shown in the last row indicates that the three schools are about the same in overall achievement. The total was determined by dividing the total number of correct responses by the total number of items on the test.

[Insert Table 6 and Table 7 here]

Table 7 shows the outcomes for the 8th graders in 1993. The data is particularly useful in identifying weaknesses. For example, School A, although it has the highest overall

average, scored significantly lower on decimals, changing a fraction to a mixed number, changing a fraction to a decimal, and evaluating algebraic expressions. As with the 7th grade, the total averages of the three schools is quite close, 67% to 64% to 63%.

MARTINA: We also wanted to know if students were making steady progress from year to year. We followed students from the sixth grade to the seventh grade to see if their performance increased.

[Insert Table 8 here]

KING: Table 8 shows that the students are continuing to make progress from year to year. For example, the students in School A scored 89 on addition in the 6th grade, and they scored 95 in the 7th. Overall, the increase was from 61% to 70% in School A and 60% to 81% in School B. It is reassuring to know that students are making steady improvement.

MARTINA: We also performed a factor analysis to determine the underlying structure of the test. The analysis is shown in Table 9.

[Insert Table 9 here]

KING: Factor analysis is a statistical procedure which clusters the individual items of a test into groups of items which have something in common. By looking at the individual items which cluster together, the researcher attempts to identify what those items have in common. Those items which cluster together are measuring the same underlying ability which is called a "factor." Let's take a look at Table 9. Items with a correlation to a factor of 0.4 or higher are consider to be part of that factor. Therefore, to simplify the table, only items with a correlation above 0.4 appear in this table. There are three identifiable factors in our test for 7th and 8th graders. Addition, subtraction, multiplication and division are all correlated to factor 1. We have named this the "Computation" factor. The next four skills in the table involve fractions, and we have named this the "Fraction" factor. The third factor is more difficult to name, for it includes

solving word problems, solving percent problems, converting measurement units, and solving algebraic equations. These involve more complex thinking patterns, and since the highest correlation occurs with the problem solving items, and for lack of a better name, we have named this the "Problem Solving" factor. The other 13 skills in the test did not cluster into any pattern.

RAYNOLD: We saw previously that division was the skill most highly correlated with overall math performance for sixth grade students. We decided to see which skill was the most highly correlated with overall performance for 7th and 8th graders.

[Insert Table 10 here.]

KING: Table 10 shows that division is the skill most highly correlated with overall mathematics performance. Why should division be the one skill which best indicates overall math ability? Well, division requires many skills, including dividing the divisor into the dividend, multiplying, then subtracting, bringing down the next digit, and so on. It stands to reason, therefore, that it would be highly correlated to overall math ability.

Who is Better, Boys or Girls?

RAYNOLD: We have included a variety of analyses in our report (factor analysis, correlations, school comparisons, items analyses, and longitudinal trends) to indicate that a good deal of information can be derived from locally-developed achievement tests. We now address the title of this presentation, Who is better in math, boys or girls?

[Insert Table 11 here]

KING: We first looked at the mean scores for each of the grades 2 to 6 in 1993. Table 11 shows that girls outperform boys on each of the subskills, and when all items are combined, the difference is statistically significant. Let me interpret the table for you. On addition, the girls, including all of them in grades two through six, averaged 57% on the addition problems. The boys, all grades combined, averaged only 49%. This was statistically significant at the .05 level of significance. This means that we are 95%

confident that this result did not occur by chance. Girls outperformed the boys on all 12 skills, and the differences were statistically significant on nine of the 12 skills. Clearly, girls are outperforming boys at the elementary school level.

[Insert Table 12 here.]

MARTINA: Table 12 gives a breakdown of the sex differences in performance by grade level for 1993. The girls outperform the boys at each grade level, although the differences are statistically significant only at the sixth grade. When all grades are combined, the results show the girls are statistically better than the boys.

[Insert Table 13 here.]

KING: The girls outperform the boys in the lower grades, so we examined the 7th and 8th grade results to see if the trend continued. Table 13 shows each of the subskills which were tested, and the girls outperform the boys on 21 of the 25 skills. The asterisks indicate those differences which were statistically significant. When all skills are combined, the results are statistically significant in favor of the girls.

[Insert Table 14 here]

RAYNOLD: The previous tables reflect the 1993 data. In 1994 we tested only the 6th, 7th and 8th grade students, and, as shown in Table 14, an analysis of the data reveals that the girls, once again, outperformed the boys. The computation component of the test included computation with whole numbers, decimals, and fractions. The application component included the other items on the test, including manipulating fractions and decimals, solving equations, and so on. The asterisks indicate the significant differences. Clearly, girls outperform the boys at each grade level. As a side note, we should observe that whereas the students do fairly well on the computational component, they do not do well on the application section of the test. For example, the 8th grade girls, who did better than the other groups, solved on 25% of the application items.

MARTINA: Using a different test, one with a multiple choice format, the Ministry of Education also tested several other elementary schools in Palau. We examined that data to see if the girls outperformed the boys. The results are shown in Table 15.

[Insert Table 15 here]

KING: Note that whereas the outcomes are not statistically significant, the girls once again scored higher than the boys. The trend continues.

RAYNOLD: We had one other source of data to examine, the results of the Standford Achievement Test which was administered in 1993. Not every student takes the exam, and so the numbers are not large. The test is administered at the 4th, 6th, 8th, 10th, and 12th grades. Table 16 shows the results.

[Insert Table 16 here]

KING: As Table 16 shows, girls outperform boys at the 4th, 6th, 8th, and 10th grades. However, by the 12th grade the boys outperform the girls. The difference at the 12th grade is not statistically significant, but for the first time the means for the boys is higher than the means for the girls. I would like to ask Raynold and Martina if they can give an explanation for why this might be the case; that is, why girls do better than boys in mathematics achievement in Palau.

MARTINA: I think this is due to the social conditions in Palau. Girls are not allowed to be away from home after school, they must go home and remain there. The boys, on the other hand, are free to roam about after school each day. Hence, girls are at home and are more likely to do their school work and to study.

KING: Then why do boys score higher in the 12th grade?

RAYNOLD: It is my guess that boys, as they get closer to graduation, begin to take their studies more seriously. In Palauan culture, women have traditionally remained at home as mothers and homemakers while the men earn the living for the family. While this is starting to change, that is, more and more girls are being encouraged to attend

college, boys are still expected to be the bread winners for the family. So as they near college age, the boys probably attend more to their studies. We should check other test scores, like Science and English and Social Studies. I think the same pattern would hold, that girls do better until the last few years of school.

KING: There are some people who believe that boys are genetically better in math than girls. The outcomes of our studies strongly suggest that social factors are just as, or more, important than genetic factors. And so to answer our original question, in Palau, girls are better in math than boys. Thank you for being such a good audience.

Table 1
Percent Gain Scores at School A
1984-1985

	Pre	Post	Gain
Second Grade			
Addition facts	23	76	53
Addition problems	19	79	60
Third Grade			
Addition facts	37	49	12
Addition problems	41	82	41
Subtraction facts	18	27	9
Subtraction problems	16	56	40
Fourth Grade			
Addition facts	56	85	29
Addition problems	67	93	26
Subtraction facts	38	61	23
Subtraction problems	47	86	39
Multiplication facts	33	64	31
Multiplication problems	17	48	31
Fifth Grade			
Addition facts	70	89	19
Addition problems	70	98	28
Subtraction facts	48	64	16
Subtraction problems	50	77	27
Multiplication facts	44	89	45
Multiplication problems	22	54	32
Division facts	27	74	47
Division problems	15	36	21

Table 2
Percent Gain Scores for Experimental Study
1986-1987

Grade Level	Experimental Group Gain	Control Group Gain	Difference in Gain Scores
2	56	38	+18
3	37	26	+11
4	43	29	+14
5	37	28	+9
6	40	18	+22

Table 3
Percent Mean Scores for Grades 2-6
1985 - 1993

School A

Grade	1985	1987	1990	1991	1992	1993*
2	76	66	40	44	56	55
3	51	55	68	45	47	46
4	79	63	58	58	68	51
5	82	74	73	74	71	58
6	- - -	86	79	82	80	67

School B

Grade	1985	1987	1990	1991	1992	1993*
2		40	45	31	41	39
3		40	69	63	43	44
4		60	81	60	57	49
5		74	80	74	74	57
6		64	80	83	83	61

* The 1993 test is different from the previous tests. Direct comparisons with previous years cannot be made.

Table 4
1993 Correlation of Math Skills with Total Test Score for Grade 6

Math Skill	R
Division Facts	.80593
Subtraction Facts	.77308
Multiplication Facts	.76910
Addition Facts	.75232
Subtraction Problems	.75017
Addition Problems	.71341
Division Problems	.69107
Multiplication Problems	.68806
Decimals	.52793
Word Problems	.44754
Fractions	.24601

Table 5
Type and Number of Items on the 7th and 8th Grade Test

Type of Problem	Number of Problems	Time Limit
Addition problems	35	5
Subtraction problems	35	5
Multiplication problems	35	5
Division problems	21	5
Word problems	8	8
Fraction problems	8	2
Decimal problems	8	2
Greater than	8	1
Reduce fractions	8	2
Fraction to a mixed number	8	2
Mixed to improper fraction	8	2
Fraction to decimal	8	2
Solve equations	8	2
Round off	8	2
Decimal to fraction	8	2
Percent problems	6	3
Convert measurements units	6	3
Square root	4	1
Square a number	4	1
Area of rectangle	2	1
Perimeter of rectangle	2	1
Evaluate expressions	6	3
Compute measurements	2	1
Odd and even	2	1
Reading Graphs	2	1

Table 6
1993 Percent Mean Scores for Seventh Grade

	School A	School B	School C
Addition	95	97	91
Subtraction	84	92	81
Multiplication	63	68	60
Division	46	56	49
Fractions	58	61	48
Decimals	45	48	39
Word problems	34	40	61
Greater than	63	65	60
Reduce fractions	89	91	79
Fraction to a mixed number	63	67	58
Mixed to improper fraction	71	73	58
Fraction to decimal	35	41	36
Solve equations	47	47	63
Round off	20	25	23
Decimal to fraction	14	13	4
Percent problems	4	5	3
Convert measurements	32	41	48
Square root	59	47	56
Square a number	43	14	44
Area of rectangle	52	50	65
Perimeter of rectangle	18	19	44
Evaluate expressions	35	35	45
Compute measurements	42	47	44
Odd and even	67	81	65
Reading Graphs	94	92	98
Total	59	64	60

Table 7
1993 Percent Mean Scores for Eighth Grade

	School A	School B	School C
Addition	96	95	95
Subtraction	94	95	95
Multiplication	72	65	63
Division	59	47	44
Fractions	76	75	61
Decimals	7	59	50
Word problems	54	3	59
Greater than	58	48	54
Reduce fractions	95	87	77
Fraction to a mixed number	9	64	60
Mixed to improper fraction	97	92	65
Fraction to decimal	8	55	46
Solve equations	7	29	50
Round off	44	15	15
Decimal to fraction	23	15	15
Percent problems	4	7	23
Convert measurements	48	38	53
Square root	52	73	73
Square a number	62	34	50
Area of rectangle	61	34	63
Perimeter of rectangle	50	50	35
Evaluate expressions	7	36	42
Compute measurements	50	50	11
Odd and even	83	69	65
Reading Graphs	50	34	50
Total	7	64	63

Table 8
Comparison of the Same Students as 1992 Sixth Graders and 1993 Seventh Graders

	School A		School B	
	1992 in 6th Grade	1993 in 7th Grade	1992 as 6th Grade	1993 as 7th Grade
Addition Problems	89	95	87	97
Subtraction Problems	81	84	88	92
Multiplication Problems	67	63	59	68
Division Problems	45	46	39	56
Word Problems	25	34	32	40
Fractions	52	58	49	61
Decimals	58	45	52	48
Total	61	70	60	81

Table 9
Factor Analysis of 1993
Seventh and Eighth Grade Math Skills

Skill	Factor 1	Factor 2	Factor 3
Subtraction	.82119		
Multiplication	.78105		
Addition	.68116		
Division	.55463		
Change improper to mixed		.71548	
Change mixed to improper		.66679	
Reduce fractions		.65858	
Change fraction to decimal		.42575	
Word Problems			.71297
Solve percent problems			.61977
Convert measurement units			.47418
Solve equations			.41337

NOTE: Only correlations 0.40 or higher are entered into the table.

Table 10
Correlation of Math Skills to Total Test Score for Grades 7-8 for 1993

Math Skill	R
Division	.77517
Multiplication	.73483
Decimals	.72005
Change fraction to a decimal	.70786
Subtraction	.70303
Evaluate algebraic expressions	.65121
Solve algebraic equations	.61599
Change improper fraction to mixed number	.60947
Round off	.58002
Addition	.56191
Fractions	.55731
Change mixed number to improper fraction	.55566
Word problems	.54757
Reducing fractions	.54619
Change decimal to fraction	.51608
Convert measurement to a different unit	.50111
Solve percent problems	.49020
Identify odd and even numbers	.46434
Square a number	.45432
Find perimeter of a rectangle	.37252
Add and subtract measurement units	.36700
Greater than, less than	.32154
Find square root	.29441
Find area of a rectangle	.15970
Interpret graphs	.05185

Table 11
1993 Percent Mean Scores for Boys and Girls
Grade 2 through Grade 6

Skills	N	Girls Means	N	Boys Means
Addition Facts	255	57 *	266	49
Addition Problems	255	78	266	74
Subtraction Facts	219	40*	214	34
Subtraction Problems	219	64*	214	58
Multiplication Facts	155	58*	155	50
Multiplication Problems	155	54	155	52
Division Facts	100	67*	102	57
Division Problems	100	42 *	102	24
Word Problems	100	31*	102	24
Fractions	40	46	44	45
Decimals	40	49*	44	38
Total	255	55 *	266	49

* Score is significantly higher ($p < .05$ level of significance).

Table 12
Sex Differences for Grades 2 - 6 in 1993

	N	Girls Mean	N	Boys Mean	F Ratio	Prob>F
Grade 2	82	37.5	106	33.2	3.73	0.0566
Grade 3	64	45.0	59	41.4	2.35	0.1281
Grade 4	55	50.8	53	47.0	1.31	0.2548
Grade 5	60	67.8	58	62.4	2.83	0.0950
Grade 6	40	78.8	44	64.3	16.83	0.0001
TOTAL	301	53.1	320	46.6	13.90	0.0002

Table 13
Percent Mean Scores for Items by Sex for Seventh and Eighth Grades in 1993

SKILLS	N	Girls Means	N	Boys Means
Addition	96	97*	83	93
Subtraction	96	92*	83	82
Multiplication	96	69*	83	59
Division	96	53*	83	44
Word Problems	95	45	83	46
Fractions	96	65*	83	57
Decimals	96	55*	83	45
Greater than	96	62	83	56
Reduce fractions	96	90	83	83
Change improper to mixed	96	74*	83	58
Change mixed to improper	96	81*	83	65
Change fraction to decimal	96	52	83	42
Solve equations	96	53	83	52
Round off	96	31	83	25
Change decimal to fraction	96	13	83	15
Solve percent problems	96	16	83	13
Convert measurement units	96	38	83	45
Find square roots	96	57	83	62
Square a number	96	45	83	42
Find area of rectangle	96	61	83	49
Find perimeter of rectangle	96	32	83	28
Evaluate algebraic expressions	96	45	83	41
Add or subtract measurements	96	38	83	41
Identify odd and even integers	96	77*	83	63
Interpret graphs	96	71	83	79
TOTAL	255	55 *	266	49

* Score is significantly higher ($p < .05$ level of significance).

Table 14
Sex Differences for 6th, 7th and 8th Grades in 1994

Grade 6

	N	Girls Mean	N	Boys Mean	F Ratio	Prob>F
Computation	64	69	52	63	4.41	0.0378 *
Application	64	15	52	13	2.26	0.1356
Total	64	84	52	76	4.62	0.0337 *

Grade 7

	N	Girls Mean	N	Boys Mean	F Ratio	Prob>F
Computation	34	83	49	75	6.34	0.0138 *
Application	34	23	49	17	7.35	0.0082 *
Total	34	106	49	92	9.17	0.0033 *

Grade 8

	N	Girls Mean	N	Boys Mean	F Ratio	Prob>F
Computation	36	89	48	82	5.24	0.0247 *
Application	36	25	48	21	4.73	0.0325 *
Total	36	114	48	103	6.47	0.0128 *

Table 15
Sex Differences for Grades 7 and 8 in 1994
The Other Study

	N	Girls Mean	N	Boys Mean	F Ratio	Prob>F
Grade 7	53	33.0	55	31.7	1.26	0.2589
Grade 8	71	43.4	76	40.8	1.91	0.1687
TOTAL	124	39.0	131	37.0	2.24	0.1355

Table 16
Sex Differences on the 1993 Stanford Achievement Test for Grades 4, 6, 8, 10 and 12

Grade Level	N	Girls Mean	N	Boys Mean	F Ratio	Prob>F
4	44	53.4	48	43.7	9.64	0.0025 *
6	50	47.6	52	37.6	12.69	0.0006 *
8	38	55.5	40	47.3	4.60	0.0351 *
10	30	38.2	12	36.3	0.13	0.7239
12	17	29.3	24	35.7	2.23	0.1433